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MOLLUSCA OF THE SOUTHWESTERN STATES, III: THE HUACHUCA MOUNTAINS, ARIZONA.

BY HENRY A. PILSBRY and JAMES H. FERRISS.

The Huachuca Mountains stand in the southwest angle of Cochise county, Arizona, their southern foothills reaching over the international boundary. The highest summits do not quite attain 10,000 feet. Northward the Whetstone range looms up, a fine if arid mountain mass, as yet unexplored for shells. On every side lies the desert, barren of molluscan life. Our purpose is to give an account, incomplete as it now may be, of the molluscan life of this range.[1]

The Huachucas have not yet been accurately mapped. The sketch

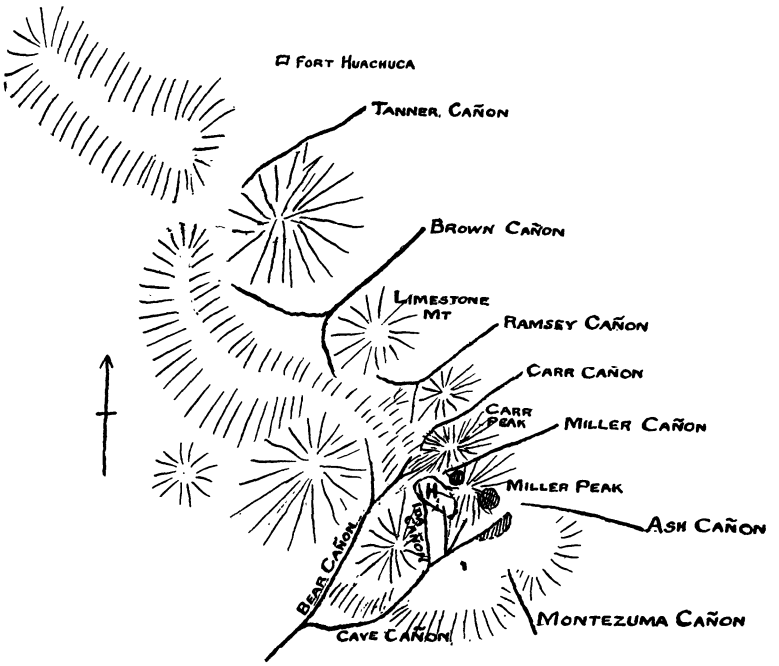

Fig. 1. Sketch-map of Huachuca Mountains.

[1] A few new records are added of species taken in river drift at Benson, Cochise county, some distance northward from the Huachuca range. These forms were derived from some other district. Other records from Benson may be found in our *Mollusca of the Southwestern States*, II, 1906, and in Dall, *Proc. U. S. Nat. Mus.*, XIX, 1896.

here given shows the general positions of localities mentioned in the text.

The first mollusks collected in the Huachucas were taken by a Mr. Cox, who sent some Helices to Dr. Isaac Lea many years ago, with the locality "Tucson." These shells are what we now call *Ashmunella varicifera*. Nothing is known of Cox beyond his name on the label. At the time these shells were collected Tucson was no doubt the nearest settlement or post to the Huachucas, and hence was put down as the locality. It is not unlikely that Cox picked up these shells in the course of a chase from the army post at Tucson after marauding Apaches. Be this as it may, *Ashmunella varicifera* is an indubitable Huachucan snail, and was collected at a time when hostile and dangerous Indians occupied that country. On the death of Dr. Lea the specimens came into the possession of the National Museum, where they are now preserved.

In 1880 Mr. Bland described a snail, *Triodopsis levettei* (now *Ashmunella levettei*), collected by Dr. G. M. Levette, and thought to be from near Santa Fé, New Mexico. Explorations in that region have shown that the Ashmunellas there are of a somewhat different type, and the true habitat of the species was not known until Mr. Ferriss rediscovered the species in the Huachucas, where it is restricted to the heads of certain canyons. It is certain, therefore, that Dr. Levette had forgotten where he procured the original specimens, which are now in the American Museum of Natural History, New York.

The first snails actually reported from the Huachucas were collected by Dr. Edgar A. Mearns, U. S. A., a member of the party surveying the Mexican boundary in 1892-1894. They were described by Dr. W. H. Dall in two papers,[2] published in 1895 and 1896. Six species were obtained in the Huachuca range:[3]

Polygyra levettei [= *Ashmunella l. angigyra*].

Polygyra mearnsi [= *Ashmunella mearnsi*].

Epiphragmophora hachitana, depressed variety from Tanner Canyon [= *Sonorella dalli*].

Patula strigosa var. [= *Oreohelix s. huachucana*].

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[2] Diagnoses of new mollusks from the survey of the Mexican boundary, in *Proc. U. S. Nat. Mus.*, XVIII, 1895, p. 1, and Report on the mollusks collected by the International Boundary Commission of the United States and Mexico, 1892-1894, same *Proc.*, XIX, pp. 333-379.

[3] Dr. Dall's pioneer work on southern Arizona shells was published prior to the anatomical researches which led to the establishment of new genera for the Helices of that region. He had only dry shells to deal with, and hence followed the generic nomenclature current at that time.

Patula s. concentrata [= *Oreohelix s. concentrata*].
Cionella lubrica [= *Cochlicopa lubrica*].

Several Huachucan species were figured by Mr. Paul Bartsch in his monograph of *Sonorella*, 1904, and *S. dalli* n. sp. was described.

The seven species of snails mentioned above sum up all that was known of Huachucan mollusks prior to the visit of Mr. Ferriss in 1902. In 1904 the range was again visited,[4] and again in 1907 Messrs. Ferriss and L. E. Daniels made extensive collections. Dr. Henry Skinner, the well-known entomologist, made a useful collection of shells in Carr Canyon, in August, 1905, and Mr. C. R. Biederman has contributed a few species from the same place.

The present report is based upon practically all of the material ever collected in the Huachucas. Through the unfailing kindness of Dr. Dall, the series in the National Museum has been examined. Dr. Gratacap has permitted a re-examination of the types of *Ashmunella levettei;* and Dr. Bartsch has assisted with various helpful services.

HELICIDÆ.

Genus **SONORELLA** Pils.

The Huachucan Sonorellas are all distinct specifically from those of other ranges. So far as known anatomically, they belong to groups special to this range; hence speak for a long isolation.

Omitting *S. huachucana*, which is unknown anatomically, the species of the Huachuca and Patagonia Mountains can be determined by this key:

a.—Penis long (about 40 mm. in a shell 27 mm. diam.), with a short hollow papilla containing a tube; epiphallus long, 49-60 mm.; flagellum present, ... *S. dalli.*

a[1].—Penis and epiphallus short, the former containing a fleshy, cylindric papilla over half the length of penis; flagellum vestigeal or wanting.

b.—Vagina about as long as penis; spermatheca and duct about four times as long, ... *S. rowelli.*

b[1].—Vagina much longer than the penis; spermatheca and duct not differing greatly from vagina in length.

c.—Penis 5 to 7.5, papilla 3.3 to 5 mm. long; upper part of vagina muscular, swollen, usually fusiform, *S. granulatissima.*

c[1].—Penis 12 to 19, papilla 9 to 13 mm. long; vagina slender, with a small fleshy node midway, . . *S. danielsi.*

[4] See Southwestern Shells, *Nautilus*, XVIII, Sept., 1904, pp. 49-52, and Mollusca of the Southwestern States, *Proc. A. N. S. Phila.*, 1895, pp. 211-290.

Sonorella huachucana Pilsbry. Pl. XIX, figs. 16, 17.

S. virilis huachucana PILSBRY, Proc. A. N. S. Phila., 1905, p. 267, pl. 17, fig. 24.

This is a non-granulose species with conspicuous pale borders along the brown band. We formerly thought it a subspecies of *A. virilis* of the Chiricahua range, but since all the other Helices of this range are specifically distinct, it is not likely that *huachucana* will prove an exception. It comes from Brown's and Bear Canyons, and must be rare or very local. None were taken in 1907.

The soft anatomy is unknown. We therefore know nothing of its relationships with other species. Fig. 16 represents a shell from Bear Canyon. Fig. 17 the type from Brown's Canyon.

Group of S. dalli.

Sonorella dalli Bartsch. Plate XIX, figs. 1, 2, 3.

Sonorella dalli BARTSCH, Smiths. Miscell. Coll., Vol. 47, p. 193, pl. 31, fig. 1 (Oct. 10, 1904).
Epiphragmophora hachitana, depressed variety from Tanner Canyon, DALL, Proc. U. S. N. M., XIX, pp. 339, 340, pl. 31, figs. 7, 10 (1896).

Specimens were taken only in Tanner Canyon, the type locality. It is probably restricted to this place. It is a fine species, distinguished by the broad, flattened shape, very open umbilicus and much deflexed last whorl. The largest specimen taken measures 28 mm., the smallest 23 mm. diameter. Compared with *S. granulatissima latior*, which also occurs in Tanner Canyon, *S. dalli* is more openly umbilicate, the aperture is flattened above, the oblique sculpture is coarser. In some old specimens the front edge of the parietal callus is thickened, a narrow ridge connecting the ends of the lip.

The penis (pl. XXII, fig. 4) is extremely long, slightly enlarged distally, its walls thin, with most minute and close transverse rugæ. It contains a smooth papilla, tapering to an obtuse apex, and about one-fifth the length of the penis. The papilla is hollow with rather thin walls. Within it a slender tube runs from the epiphallus to the apex, where it opens by a lateral pore. This tube is lightly attached to the wall of the penis-papilla. It is indicated by dotted lines in fig. 4. The epiphallus is extremely long, terminating in a short flagellum. The penis retractor muscle, 7 mm. long, is inserted upon it 4 mm. from the end of the penis. The long vagina has a slender neck, enlarging moderately above.

The spermatheca is globular, on a duct much shorter than the penis.

In one specimen dissected it bears a minute diverticulum about 1 mm. long, 2 mm. from the base of the duct. In another individual no diverticulum was found, so that it may possibly be abnormal or pathologic. The measurements of the organs in two individuals preserved in formalin follow:

	No. 94,384.	No. 94,358.
Length of penis,	39 mm.	41 mm.
" " penis-papilla,	8 "	9 "
" " epiphallus,	49 "	60 "
" " flagellum,	4 "	3 "
" " vagina,		25 "
" " spermatheca and duct,	34 "	27 "

The jaw (pl. XXII, fig. 6) has five strong ribs grouped in the middle half of its length.

The radula has about 41, 1, 41 teeth (pl. XXII, fig. 8). The central and lateral teeth have mesocones only; on the 17th an ectocone appears. On the outer marginal teeth the inner cusp or sometimes both cusps are bifid, but the ectocone is not split into several cusps as in some other species.

The excessive length of penis and epiphallus, and especially the hollow, thin-walled papilla containing a separate duct or tube (a structure unique in the genus), are characters which set *S. dalli* apart from all other known Sonorellas. It stands alone in its own line of differentiation.

Group of S. granulatissima.

These forms are closely related to the group of *S. hachitana*, but differ by the thick, quite cylindric penis-papilla, solid except for the minute perforation, and very obtuse or truncate at its distal end, and by having no flagellum or only a minute vestigeal one. In the *hachitana* group the papilla tapers, at least at the distal end, and a minute but distinctly developed flagellum is present in known forms. The distinction is only a small matter, but serves to distinguish the Huachucan forms. *S. rowelli* (Newc.), from a little farther west, belongs to the same group.

The dimensions of the genitalia in several specimens of each form are given in the accompanying table. Most of the specimens were preserved in alcohol in the field, and some variation is doubtless traceable to various degrees of contraction.

Species, Locality and Museum No.	Penis.	Papilla.	Epiphallus	Flagellum.	Vagina.	Spermatheca and duct.	Diam. of shell.
S. granulatissima.							
Ramsey, 83,257	7.3	4.8	6	0.7	21	24–25	19
Miller Cn., 94,336	6	4	.....	0	28	22	21
Carr Cn., 90,404	5.5	4	.....	0	16	.....	18
S. g. latior.							
Tanner Cn., 94,387	6	3.5	5	0	17	16	21–22
Brown Cn.,94,356	6	4.5	6	0	21	.....	18.5
Brown, w. fork, 94,359	5	3.3	4	0	14	.....	18
Salvation, 94,395	7	5	.....	0	27	.....	20
Limestone Mt., 94,393	7.5	.....	.....	0	21	.....	23
S. danielsi.							
Head of Bear, 94,318[5]	18.5	13	10	0	27.5	22	19
Ditto, 94,317	15	10	.....	0	.....	.....	18.5
E. fork Cave, 94,352	12	8.5	.....	0	17.5	.....	19
Miller Pk., 94,337	13.5	9	10	0	19	25	18–19

Sonorella granulatissima Pilsbry. Pl. XIX, figs. 7, 8, 9; pl. XXI, figs. 1–4.

Proc. A. N. S. Phila., 1905, p. 262, pl. 17, figs. 21–23; pl. 18, figs. 41–43, 51–54.

The typical form is found in Ramsey (figs. 7, 8), Carr and Miller (fig. 9) Canyons. Types were from Ramsey. The shell is distinguished by its very dense beautiful granulation and the faintness or absence of spiral lines, though on some specimens they are present, but very weak.

I have examined the genitalia in a number of individuals from each of the three canyons mentioned above. Figs. 1, 2, 3 represents one of the two cotypes. Fig. 4 is from an example from Miller Canyon. The chief feature is that the *upper part of the vagina has thick muscular walls,* the outer layer consisting of glossy circular muscular fibers. Usually this part is *more or less swollen and fusiform.* The lower part of the vagina is thin-walled. This feature was conspicuous in every one of about 20 individuals of 12 lots of *S. granulatissima* and *S. g. latior* which were examined. The penis is short, its length contained 3 or 4 times in that of the vagina. It is abruptly truncate distally. The penis-papilla is quite short, 3.3 to 5 mm. long, cylindric, truncate at the end, and coarsely wrinkled. It is fleshy, perforated by a minute pore, which opens at the end. The rather short epiphallus has no flagellum in any example opened with the exception of one of the cotypes, in which there is a minute, vestigeal flagellum about 0.7 mm.

[5] Measured from a fresh, drowned example.

long, and bound to the vas deferens by the outer muscular fascia. As a rule, with rare exceptions, therefore, the flagellum is absent.

Sonorella granulatissima latior Pils. Pl. XIX, figs. 4, 5, 6.

Proc. A. N. S. P., 1905, p. 264, pl. 18, figs. 24–28.

Usually a larger shell than *S. granulatissima*, the last whorl more depressed, approaching *S. dalli* in shape. Originally described from Brown's Canyon, it is now known also from the south side of Limestone Mountain, east fork Salvation Ridge[6] and from Tanner Canyon. Three cotypes are figured.

The genitalia have been examined in numerous examples from Tanner Canyon (pl. XXI, fig. 6), Brown's Canyon, east fork of Salvation Ridge and Limestone Mountain. The characters are identical with those of *S. granulatissima*. All of them have the upper part of the vagina swollen, and there is no flagellum. Measurements of several alcoholic specimens are given in the table.

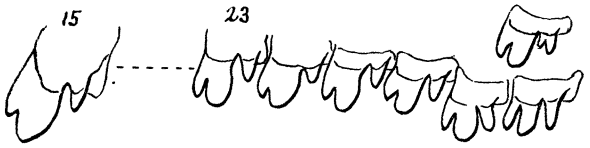

Fig. 2. Marginal teeth of *S. g. latior*, Tanner Canyon.

The radula has 38, 1, 38 teeth, with 10 laterals. The outer marginal teeth have the inner cusp deeply bifid, the outer one sometimes split (fig. 2, No. 94,383, Tanner Canyon).

Sonorella granulatissima parva Pils. Pl. XIX, figs. 10, 11, 12.

No further information on this small race from the northwestern end of the range has been received. *S. mearnsi* Bartsch, from 4 miles south of the international boundary, a few miles east of the San Pedro river, is another form which will probably prove to be closely allied to *granulatissima* and *rowelli* when the anatomy can be examined.

Sonorella danielsi n. sp. Pl. XIX, figs. 13, 14, 15; pl. XXI, figs. 5, 7.

S. granulatissima (in part), PILSBRY, Proc. A. N. S. P., 1905, p. 263, pl. 18, figs. 39, 40, 44; pl. 11, fig. 10 (Miller Cn.); also pl. 18, figs. 36, 37, 38 (Ida Cn.).

The shell is more depressed than *granulatissima*, yellow with a conspicuous dark band without pale borders, the early whorls flesh-colored; surface glossy, the granulation of the last whorl very weak,

[6] Salvation Ridge forms the divide between Brown and Tanner Canyons on the northeast side and what we supposed to be Salvation Camp Canyon on the south. We collected only on the ridge, which is shown on the map at the heads of Brown and Tanner Canyons.

nearly effaced, spiral incised lines well developed above the periphery. Umbilicus wider than in *granulatissima*.

Alt. 10, diam. 19 mm.; whorls 4½.

The animal is slaty-blackish, the back paler, brownish-gray, collar of mantle dark slate. The sole is slate colored at the sides, the middle gray, but the areas are not bounded by lines. The lung has faint venation; pulmonary vein breaking up into several large branches.

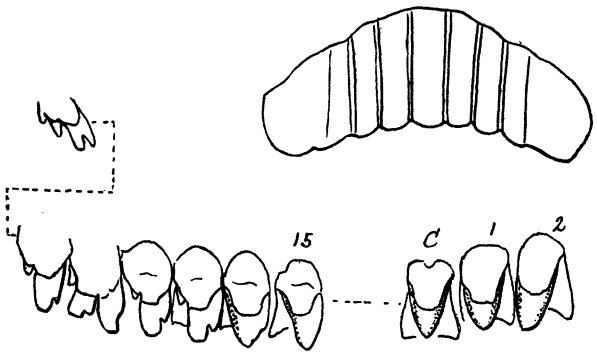

Fig. 3. Jaw and teeth of a cotype of *Sonorella danielsi*.

Genitalia.—The penis is very large, stout, subcylindric, half the length of the vagina or longer. It collapses at the base, where not filled by the papilla, and has several strong longitudinal folds inside. It contains a long cylindric papilla which is abruptly truncate at the end and wrinkled throughout. There is no flagellum. The long vagina is rather slender throughout, with an annular swelling or node about midway of its length. It is longitudinally rugose within, the rugæ coalescent at the node. Other organs as usual. Fig. 7 was drawn from a drowned specimen which had not been in alcohol (No. 94,318).

The jaw has six or seven very low, wide ribs, parted by narrow intervals. The radula has about 47, 1, 47 teeth. In most rows the fifteenth tooth has an ectocone. *No marginal teeth with the ectocone bifid* were seen. The nineteenth tooth, in the radula figured, is abnormal. One of the outer marginals is shown above it.

Types No. 94,318 A. N. S. P., from head of Bear Canyon; also Miller Peak and east fork of Cave Creek.

Similar forms, but with the ground-color not yellow but pale brown (as in *granulatissima*), occur in Ida Canyon, Cave Creek and Ash Canyon (pl. XIX, fig. 18).

This species replaces *granulatissima* on the south side and east end

of the Huachuca range. It differs from *S. granulatissima* chiefly in the genitalia, the larger penis and the shape of the vagina being constant features in the series of both species dissected. Specimens have been dissected from five lots, from the head of Bear Canyon (fig. 7), east fork of Cave, and from Miller Peak (fig. 5). One individual of several from the latter place seems to have the very minute bud-like vestige of a flagellum.

The shell will be recognized by its yellow, glossy surface and depressed shape. The brownish forms from Ida and Ash Canyons, mentioned above, require more study, with better fresh or alcoholic material than we can command at this time. One from Ash Canyon is figured, fig. 18.

Named in honor of Mr. L. E. Daniels, who accompanied Mr. Ferriss in the expedition of 1907.

Genus **ASHMUNELLA** Pils. and Ckll.

The Ashmunellas of the Huachuca range, while very diverse in appearance, belong to a single closely related group. Probably all descended from an ancestral stock not unlike *A. levettei angigyra*, the most widely distributed form, and the one showing most affinity to species of the Chiricahua and other ranges. The common ancestry of the whole series is demonstrated by the intermediate stages found among the shells, and by the soft anatomy, which is so much alike in all that it would probably be impossible to tell the species apart without the shells, yet differing characteristically from the soft parts of all Ashmunellas of the Chiricahuas or other ranges by the sacculated or varicose spermatheca and the shape of the penis.

The species and races form a beautiful chain of variations, pretty completely connecting those having most complicated apertures with those in which the aperture is toothless, thus: *bifurca—levettei—ursina—heterodonta—varicifera.*

Evolution has proceeded from fully toothed apertures towards toothless apertures. In other words it has been retrogressive, marked by degeneration of complex structures.

Soft Anatomy of Ashmunella.—Time has not admitted a full examination of the anatomy, but the genitalia of many individuals have been studied. These organs are so similar in all of the forms that one description will suffice. The penis (P.) is rather large for an Ashmunella. Inside it has six unequal fleshy longitudinal ridges, interrupted in the middle (pl. XX, fig. 6). This point is marked externally by a slight constriction. The epiphallus (*epi.*) is very long, terminating in a minute flagellum (*fl.*). The retractor muscle (*rp.*)

is attached to the epiphallus, but sends down a band to the apex of the penis. The vas deferens (*vd.*) is very long and free. The vagina is short. Spermatheca (*sp.*) is not distinctly divided into head and duct. The distal two-thirds or more is of about equal caliber, and *distinctly varicose or sacculated.* The proximal portion is a little contracted. This form of spermatheca is special to the Huachucan species, and unlike those of other districts. The other organs show no peculiar features. The dimensions of the organs in millimeters are as follows:

Species.	Penis.	Epiphallus and flagellum.	Flagellum.	Vagina.	Spermatheca and duct.	Diam. of shell.	Museum No.
A. angigyra, Ramsey Cn.		24	1.3	3	22	13–14	83,269
A. angigyra, east fork Salvation	5	28	.....	4.5	22.5	.....	94,396
	.....	28	.....	.....	21		
A. bifurca, Tanner Cn.	5	34	1.5	4	29	15	94,388
	4.5	31	.....	4	.....		
A. ursina	7	42	.....	4	28	16–18	94,351
	8	43	.....	3.5	26		
A. ursina, Bear Cn.	5	46	1.5	4	32	16	94,349
A. heterodonta, Cave Creek.	7	34	.....	5	24	16	94,350
A. microdonta, Cave Creek.	8	40	1	7.5	26	19	94,347
A. varicifera, Wickersham Rock	7.5	35	1.5	5	27	18	94,340
	6	29	1.8	4	25	17	94,341

All the specimens were measured from alcoholic preparations except *A. levettei ursina*, 94,349, which was dissected fresh.

The figures on plate XX represent the following species:

A. levettei ursina, No. 94,351, head of Bear Canyon (pl. XX, fig. 1).

A. levettei ursina, No. 94,349, head of Bear Canyon (pl. XX, fig. 4). Atrium protruding.

A. l. angigyra, No. 83,269, Ramsey Canyon; type lot (pl. XX, fig. 2).

A. l. heterodonta, No. 94,350, head of Cave Creek.

A. microdonta, No. 94,347, head of Cave Creek; type lot (pl. XX, fig. 7).

A. varicifera, No. 94,340 and 94,341, Miller Peak, Ash Canyon side (pl. XX, fig. 3). Atrium protruding. Fig. 6, the penis opened. Fig. 5, spermatheca of another individual.

Ashmunella varicifera Ancey. Fig. 4.

Polygyra chiricahuana, in part, Dall, Proc. U. S. Nat. Mus., XIX, pl. 32, figs. 9, 10, 12.

A. chiricahuana var. *varicifera* Anc., Journ. of Malacology, VIII, Sept. 30, 1901, p. 77 (near Tucson, Cox). *A. l. heterodonta* or *chiricahuana*, Pilsbry, Proc. A. N. S. Phila., 1905, p. 242, pl. 15, figs. 94, 95.

The shell is depressed, the spire low, varying from convex to low-conoidal, the periphery of the last whorl situated above the middle, obtusely subangular in front. Color rather light-brown and opaque; or corneous-brown and somewhat transparent (sometimes pure white). Surface rather glossy, lightly marked with growth-lines and faint traces of incised spiral lines. Umbilicus rather narrow but open. Aperture oblique, at about 45° with the axis. Peristome rather narrow,

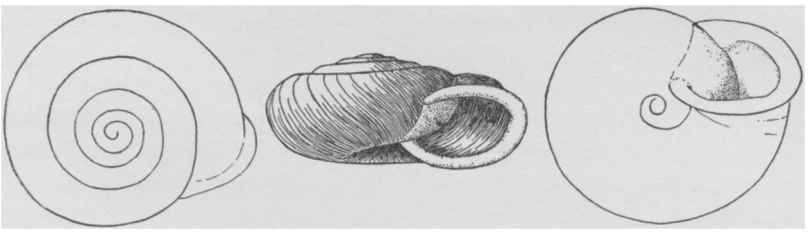

Fig. 4. *Ashmunella varicifera* Ancey.

reflexed, recurved at the edge, having a low, indistinct thickening of the inner rim of the outer lip, and sometimes the very slight indication of an outer basal tooth.

At resting stages young shells form a callous thickening within the lip, which shows through as a radial streak in some adult shells.

Alt. 8, diam. 16½ to 17 mm.; whorls 5½.
" 10½, " 18½ " " 6.

South side of Miller Canyon near its head; Wickersham Rock, Miller Peak, and in the east fork of Cave Creek Canyon; also a mountain on the south side of the mouth of Ash Canyon. These localities, except the last, are indicated by three areas of vertical shading on the map. Miller Peak is about 9,800 feet high.

This species has not been fully described before. The "varices" to which the name is due are only occasionally present in adult shells. They are also seen in *A. chiricahuana*, which is so similar that until now the Chiricahuan and Huachucan snails were supposed to belong to one species. The soft anatomy shows at once that we have to do with two species. *A. varicifera* has genitalia exactly like *A. levettei* except that the epiphallus is somewhat shorter. The spermatheca is not differentiated from its duct, the whole form a long somewhat

varicose cylindric body, while in *chiricahuana* the duct is extremely long, swollen at the end. The proportions vary widely in the two species, as follows:

	A. varicifera.	*A. chiricahuana*
Length of penis, epiphallus and flagellum,	37 to 44 mm.	73 mm.
Length of spermatheca and duct, . . .	25 to 27 "	56 "
Length of vagina, ...	4 to 5 "	9 "

The size of the shells is about equal. It appears from this that *A. varicifera* is a simplified member of the *A. levettei* stock, while *A. chiricahuana* belongs to another group of species.

The type locality of *A. chiricahuana* is Fly Park, Chiricahua Mountains.

Extract from Mr. Ferriss' Field Notes.—On the Cave Creek side we found *A. varicifera* larger than the lot from Wickersham's Rock on the peak, and generally albino. Out of one hole containing 29, only two were dark colored. On the other side of the east fork of Cave Creek they were larger but all dark. On the south side of the range there is a strong tendency to albinism in the Ashmunellas, Sonorellas and Oreohelix.

Ashmunella microdonta n. sp. Fig. 5.

The shell resembles *A. varicifera* in general appearance, but differs by having fewer whorls, the last wider viewed from above; umbilicus much wider, exposing more of the penultimate whorl. The lip is toothless except for a very low vestige in the basal margin in some specimens; but there is a minute tubercular parietal tooth in over

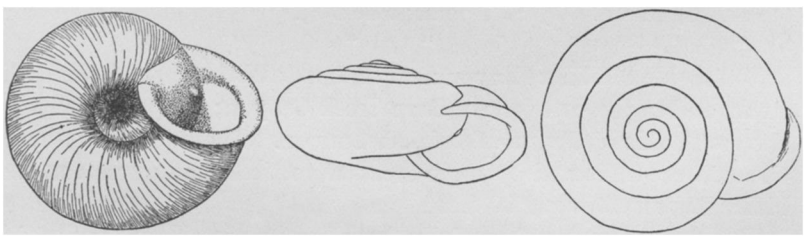

Fig. 5. *Asmunella microdonta.* Cotype.

half of those examined, while it is perceptible as a faint thickening in all. The shell is chestnut colored, usually with one or two varix-streaks on the base; lip white or with its upper half reddish-brown.

Alt.	9.5	8.6	8.8	8.2 mm.
Diam.	20	19	19	17 "
Whorls	5½	5⅓	5½	5⅓ "

Cave Creek Canyon, for one-eighth of a mile at the head.

This is another modification of the *levettei* stock, differing from *heterodonta* and *varicifera* by its wider umbilicus and less closely coiled whorls, from the former by deficient lip teeth, and from the latter by the usual presence of a minute parietal tooth. In genitalia it does not differ from typical *levettei*. While not conspicuously differentiated, we have thought it well to give the form specific rank.

Ashmunella levettei heterodonta Pils. Fig. 6.

Proc. A. N. S. Phila., 1905, 241, pl. 15, figs. 81–91. Nautilus, XVIII, p. 51.

This form has the shape of *A. levettei*, and typically has a low, straight-topped tooth within the outer lip, a small tubercular tooth at junction of outer and basal margins, and a faint prominence in the position of an inner basal tooth. The parietal tooth is minute or wanting. There are barely over 6 whorls, which therefore are a little wider than in *A. levettei*.

We have elsewhere noted the extreme variability of the teeth in *heterodonta*. They may be much more developed than described above, or so degenerate that only faint traces of teeth are discernible. A form-chain connecting *levettei* and *varicifera* exists. Whether hybridism plays a part here remains uncertain.

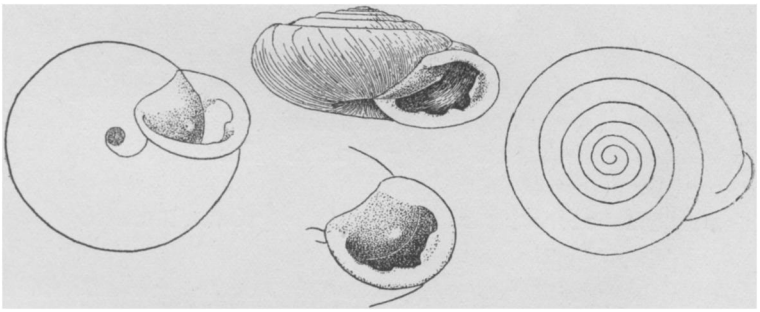

Fig. 6. *Ashmunella levettei heterodonta*. Cotype.

This form occurs in the heads of Ida and Cave Canyons. In one place *heterodonta* goes over the divide two or three hundred feet, but in no other case do these species cross to the other side of the range. *A. levettei* or *heterodonta* are not found in *varicifera* territory. There is no mingling of Ashmunellas except large and small forms of *levettei*. The peculiarities of habit, variation, etc., of the Ashmunellas, Oreohelices, etc., is worthy of a year's study in the Huachucas. The area

of *heterodonta* is marked H on the map. Cave Creek Canyon, like that of the same name in the Chiricahua range, has a large basin and many branches.

Ashmunella levettei ursina n. subsp. Fig. 7.

A. levettei Pilsbry, Proc. A. N. S. Phila., 1905, p. 238, pl. 15, figs. 72–78.

The shell is like *A. levettei*, capacious and glossy. The aperture is less obstructed by the teeth. *The parietal tooth is smaller, straight,* not curving inward at the axial end, or almost imperceptibly so, and *without an outer branch* running towards the upper insertion of the lip.

Alt. 9, diam. 18, diam. aperture 8.5 mm.; whorls fully 6½.
" 7.2 " 16 mm.; whorls 6⅓.

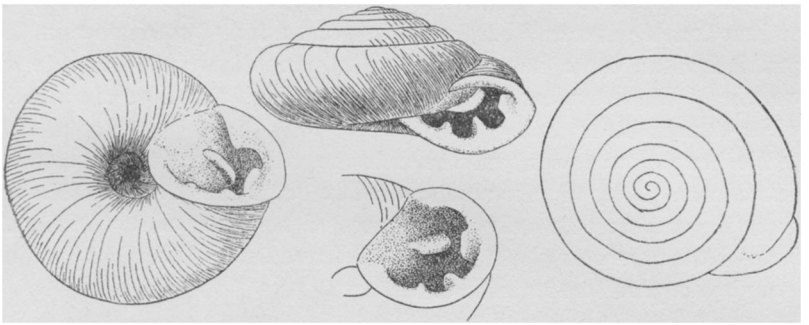

Fig. 7. *Ashmunella levettei ursina.* Type.

Head of Bear Canyon, about 7,500 feet elevation. Types No. 87,089 A. N. S. P. It also occurs in the head of Miller Canyon. In Bear Canyon there are many beautiful albino specimens, occurring with others of the normal chestnut color. The range of *ursina* lies westward from that of *heterodonta.*

This is the race formerly referred by us to typical *A. levettei.*

Ashmunella levettei (Bland). Fig. 8.

Triodopsis levettei Bland, Annals of the New York Academy of Sciences, II, 1882, p. 115, cuts. Binney, Manual of American Land Shells, p. 385, fig. 419. Gratacap, Bull. Amer. Mus. Nat. Hist., XIV, p. 383.

The type specimen of this species (fig. 8) was supposed to come from Santa Fe Canyon, New Mexico, but it is distinctly of Huachucan type. The periphery is rounded. The glossy surface is marked with fine growth-wrinkles, and on the last whorl very fine and very faint spiral lines. The parietal callus is distinct, but thin at the edge. The parietal tooth is long, high, straight, but at the axial end it becomes low and *curves strongly inward.* From the distal end of the tooth a

low but distinct branch runs towards the outer termination of the lip. This branch is brownish, like the callus it rests upon, hence might easily be overlooked. The outer lip-tooth is slightly emarginate at the top, and curves inward. The outer basal tooth is compressed and larger than the inner one, which is also somewhat compressed.

Alt. 8, diam. 16 mm.; diam. of aperture 7.9 mm.; whorls 6½.

Description and figure from the type specimen, No. 1,274 of the Binney and Bland Collection, American Museum of Natural History, New York. We owe the opportunity of studying this specimen to the kindness of Dr. L. P. Gratacap.

Some specimens from Miller Canyon are identical in characters with the type of *levettei*. It probably was collected in that canyon.

In Carr Canyon there is a similar race having some differential characters. Dr. Henry Skinner collected a series of several hundred shells. They were taken about midway of the canyon as shown in the map. These shells vary in size:

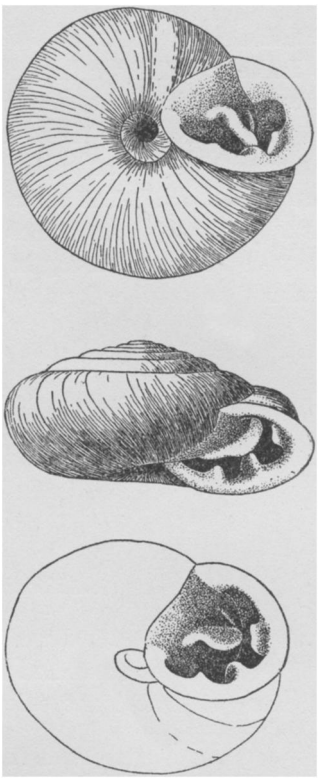

Fig. 8. *Ashmunella levettei* (Bland). Type specimen.

Alt. 6, diam. 13 mm.; whorls 6¼.
" 7 " 13 " " 6⅓.
" 7.5 " 15 " diam. aperture 7 mm.; whorls 6½.

The last whorl is rather depressed and periphery is slightly angular in front, these being the main differences from typical *A. levettei*. In some specimens the shape of the aperture and of the parietal tooth is exactly as in *levettei*, but most examples have the aperture smaller, the lip-ends approaching somewhat more, and connected by the *thickened* edge of the parietal callus. The parietal tooth almost always is recurved at the axial end, and bears a more or less distinct recurrent branch from the distal end, as in *levettei*. In some examples, however, the parietal tooth is straight and there is no perceptible outer branch; the upper margin of the lip descends more deeply on the parietal wall than in the type of *levettei*. The young snails form a very thick lip-callus at resting stages.

This Carr Canyon race is intermediate between typical *levettei* and *bifurca*.

Ashmunella levettei bifurca n. subsp.

In Tanner Canyon the shells resemble those of Carr Canyon. They are glossy, dark chestnut colored, depressed, the last whorl angular in front. The aperture is small, the lip-ends connected by a distinct, often heavy parietal cord. The outer lip-tooth is pushed farther back into the mouth. The parietal tooth curves inward at its axial end, and usually gives off a distinct branch from the distal end, though this may be weak or wanting in some examples. The umbilicus is usually wider than in other forms of *levettei*. The whorls coil closely.

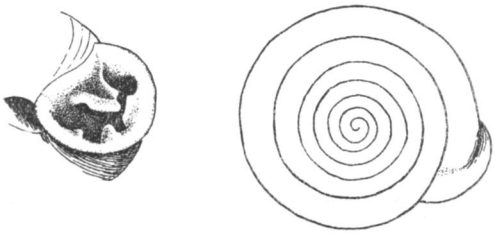

Fig. 9. *Ashmunella levettei bifurca*. Type.

Alt. 6.6, diam. 15, diam. of aperture 6.9 mm., whorls fully 6½.

This race is intensified in the development of apertural teeth. *A. mearnsi* (Dall) is more depressed and has less numerous, less closely coiled whorls.

The spermatheca is more slender, scarcely sacculate or less conspicuously so than in other Huachucan species, and is a little enlarged towards the end, the lower part of the duct slender.

Ashmunella levettei angigyra Pils.

Proc. A. N. S. Phila., 1905, p. 240, pl. 14, figs. 47–54 (shell); pl. 21, fig. 28 (genitalia); pl. 22, fig. 12 (teeth); pl. 23, fig. 14 (jaw).

Smaller, more depressed than *levettei*, and more or less angular at the periphery, teeth contracting the aperture more.

The types, described and illustrated as above cited, were from Ramsey Canyon (called "Conservatory Canyon" in the original paper). Those from northwestward and along the warm dry slopes of the ridge are more typical of the race, being smaller and more angular. The parietal tooth is straight and rather small, without an outer branch. It occurs along the northeastern side of the range from northwest to southeast as follows: Babokomari Creek; Fort Huachuca; Tanner Canyon, over the range, west fork, and along cliffs south of

the canyon; Brown's Canyon; Limestone Mountain, 9,000 feet; Ramsey Canyon; also over the range on the foothills of Bear Canyon at about 5,000 feet, where it is very widely separated from other known localities, and very small, diam. 9.5 to 11 mm.

The race from Carr Canyon is intermediate between *angigyra* and *levettei* in size and shape of the last whorl. The examples from Lime-

Fig. 10. *Ashmunella levettei angigyra.* Cotype.

stone Mountain and Salvation Ridge approach those of Carr Canyon in size and apertural teeth, and would probably be grouped with that race rather than with typical *angigyra*, if the two be separable.

A. l. angigyra is the common and widely distributed *Ashmunella* of the Huachucas. The other forms are very local.

The epiphallus is curiously flattened, dumbbell-shaped in section in several individuals (alcoholic) from east fork of Salvation Canyon, and the lower part of the spermatheca duct is slender.

Ashmunella mearnsi (Dall).

Polygyra mearnsi Dall, Proc. U. S. Nat. Mus., XVIII, 1895, p. 2 (Hachita Grande and Huachuca Mountains); XIX, 1896, p. 343, pl. 32, figs. 7, 8, 11.

This species was described as from two widely separated localities. It differs from all other Huachucan species by having fewer, less closely coiled whorls. In these features it belongs to a small group of forms from southwestern New Mexico, composed of *A. walkeri* Ferriss and *A. kochi* Clapp. We have much to learn about the snails of these alluring desert mountains, but it seems likely that there was a mistake in the locality Huachuca Mountains, and that the species really came from the Hacheta Grande Mountains only.

Genus **OREOHELIX** Pilsbry.

The Huachucan Oreohelices have been described and illustrated as fully as possible to us in the first paper of this series.

Oreohelix strigosa concentrata (Dall).

Carr Canyon, 7,000 feet; Limestone Mountain, 8,000 feet; Miller Peak, Ash Canyon. The shells from Miller Peak are rather openly umbilicate

and have a peculiar facies. Some greenish-white ones remind one of *Circinaria concava*.

Oreohelix strigosa huachucana (Pils.).

Ramsey, Brown, Carr, Miller, Cave Creek and Ida Canyons; north side of Miller Peak.

Genus **THYSANOPHORA** Strobel.

Thysanophora hornii (Gabb).

Manilla mine, near the northwest end of the range.

UROCOPTIDÆ.

Holospira ferrissi Pils.

Manilla mine, near the northwest end of the range. The locality Fort Bowie, formerly cited by us, was an error.

LIMACIDÆ.

Agriolimax hemphilli ashmuni Pilsbry and Vanatta.

Nautilus, XXII, p. 108.

Limaces are rare in Arizona, but Mr. Ashmun took specimens at Nogales, Pima county, 4,000 ft. elevation, and they were found by one of us in Miller, Brown and Tanner Canyons in the Huachucas.

These slugs belong to the very widely distributed group of *Agriolimax lævis*, but we have not been able to refer them directly to any described race. By the development of entocones on the lateral teeth they differ from *A. campestris* (including *montanus* Ing.), and agree with *A. hemphilli* (Binney),[7] *A. stenurus* (Strebel)[8] and *A. berendti* (Strebel).[9] Whether these forms are specifically distinct or not remains to be determined. Their distinctive characters do not seem important.

The alcoholic specimens from Miller Canyon have the general aspect externally of *A. campestris*. The rounded back is black, flanks sooty brown. The mantle is large, and more than half of it is free, so that when lifted and turned back it more than covers the posterior adnate portion. Under it the surface is yellowish. The sole is very narrow, conspicuously tripartite. The central tooth is tricuspid. Laterals have a small entocone elevated on the side of the mesocone; ectocone

[7] *Limax hemphilli* W. G. Binney. *Third Supplement to Terrestrial Mollusks*, V, 1890, p. 201, pl. 1, fig. 13; pl. 2, fig. 3; pl. 8, fig. E (Julian City, Cal.). *Fourth Supplement*, p. 166, pl. 3, fig. 1 (var. *pictus* Ckll., San Tomas River, L. Cal.).

[8] *Limax stenurus* Strebel, *Beitrag Mex. Land und Süsswasser Conchyl.*, IV, 1880, p. 21 (State of Vera Cruz, Mexico).

[9] *Limax berendti* Strebel, t. c., p. 22 (Coban, Guatemala). Cf. also *L. jalapensis* Strebel, *l. c.*

well developed. There are 13 lateral teeth, the 13th being transitional to the marginals, which are simple, thorn-shaped. Jaw as usual. The penis is large, much twisted, terminates in an obtuse "flagellum" or blind sack, and it has a fleshy sensory papilla in the anterior enlargement, shown by dotted lines in fig. 8 *c*. In front of this enlargement it is very slender. It has an extremely slender retractor muscle (*p.r.*). Other organs as usual in the group.

Examples from Tanner Canyon have the same genitalia, but differ

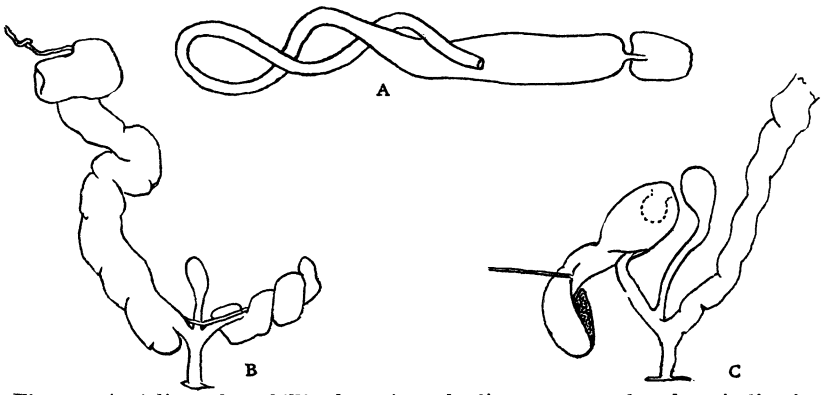

Fig. 11. *Agriolimax hemphilli ashmuni*. *a*, *b*, alimentary canal and genitalia of a specimen from Nogales. *c*, genitalia of the type from Miller Canyon.

in external color. They are pale soiled buff, with a slightly darker reticulation back of the mantle, which is closely flecked with gray. These slugs are therefore not unlike *A. hemphilli pictus* Ckll.

According to Mr. Binney, *A. hemphilli* has 50, 1, 50 teeth with 10 laterals. This is somewhat unlike our slug, which has more lateral teeth, though of the same shape; moreover, the penis of *A. hemphilli* seems to differ from the Arizona form, which occurs in a region otherwise wholly diverse in its mollusk population. *A. stenurus* and *A. berendti* of Strebel belong to the tropical fauna. Since the Arizona form differs materially in dentition from the described alpine slugs of Colorado, we have thought it safest to give a special name to the mountain slug of Arizona, until such time as the several forms can be actually compared by some observer, and their relations to one another elucidated.

The types of *A. hemphilli ashmuni* are No. 94,366 A. N. S. P., from Miller Canyon, Huachuca Mountains.

ENDODONTIDÆ.

Pyramidula (Gonyodiscus) cronkhitei (Newc.).

Wickersham's, Miller Peak; Carr Canyon.

Pyramidula (Gonyodiscus) shimeki cockerelli Pils.

"Reef," Carr Canyon, at 5,000 feet (C. R. Biederman).

Radiodiscus millecostatus Pils. and Ferr.

Carr Canyon; Miller Peak, near the top and on the north side, and in Wickersham's Gulch; Wickersham's.

Helicodiscus eigenmanni arizonensis Pils. and Ferr.

Found in 1904, no special locality recorded.

ZONITIDÆ.

Zonitoides arborea (Say).

Wickersham's Rock, Miller Peak; Tanner Canyon; Ash Canyon.

Zonitoides minuscula (Binn.).

Wickersham's, Miller Peak; Tanner Canyon; Benson.

Zonitoides minuscula alachuana (Dall).

Ash Canyon; Wickersham's.

Zonitoides milium meridionalis Pils. and Ferr.

Wickersham's.

Vitrea indentata umbilicata (Ckll.).

Tanner Canyon; Wickersham Gulch; Miller Canyon, one very large example, diam 6.7 mm.; Ash Canyon.

Euconulus fulvus alaskensis Pils.

Wickersham's rock, Miller Peak.

Vitrina alaskana Dall.

Wickersham's, Miller Peak.

SUCCINEIDÆ

Succinea avara Say.

Tanner and Ash Canyons.

VALLONIIDÆ.

Vallonia perspectiva Sterki.

Tanner, Pine and Ash Canyons; Wickersham's, Miller Peak.

Vallonia cyclophorella Ancey.

Wickersham's, Miller Peak.

PUPILLIDÆ.[10]

Pupilla hebes (Ancey).

Wickersham's, Miller Canyon.

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[10] *Pupoides hordacea* (Gabb) and *Pupilla syngenes* (Pils.) were found in river drift at Benson. Of the latter both dextral and sinistral shells, one of each.

Bifidaria quadridentata Sterki.

Wickersham's, Miller Canyon. One specimen.

Bifidaria ashmuni Sterki.

Ash Canyon.

Bifidaria cochisensis Pils. and Ferr.

Tanner Canyon, abundant. This form and the following will be described in the next paper of this series, in connection with a general review of the group of *B. ashmuni.*

Bifidaria cochisensis oligobasodon Pils. and Ferr.

Ash Canyon.

Bifidaria pilsbryana Sterki.

Wickersham's, Miller Peak.

Bifidaria tappaniana (C. B. Ad.).

Tanner Canyon, 6,000 feet; also San Pedro drift at Benson.[11]

Vertigo ovata Say.

Ash Canyon; Tanner Canyon, 6,000 feet; also San Pedro drift at Benson.

Vertigo modesta parietalis Anc.

Wickersham's, Miller Peak.

Vertigo concinnula Ckll.

Wickersham's, Miller Peak; one immature shell.

Vertigo milium Gld.

Tanner Canyon, 6,000 feet; drift of San Pedro river at Benson.

FERUSSACIDÆ.

Cochlicopa lubrica (Müll.).

Tanner Canyon, 6,000 feet; Carr Canyon; Wickersham's, Miller Peak.

LYMNÆIDÆ.

Lymnæa parva Lea.

Ash Canyon; a few very young specimens.

PHYSIDÆ.

Physa virgata Gld.

Small, slender, long-spired examples, clearly of the *virgata* type, were taken in Tanner Canyon, in a spring at about 6000 ft.

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[11] *Bifidaria pentodon* (Say) was taken in San Pedro drift at Benson, Cochise county, Arizona.

AMNICOLIDÆ.

Paludestrina stearnsiana Pils.

Ash Canyon, one bleached specimen; spring in Tanner Canyon, numerous living examples.

PELECYPODA.

Pisidium abditum huachucanum Pils. and Ferr.

Stream in Carr Canyon (C. R. Biederman, type loc.); spring in Carr Canyon, 7,000 feet; springs in Tanner Canyon at 6,000 and 7,000 feet; spring at the mouth of Ash Canyon, 4,500 feet; artificial pond at the mouth of Hunter Canyon, 4,500 feet (L. E. Daniels, October, 1907).

This is, we believe, the only *Pisidium* recorded from Arizona.

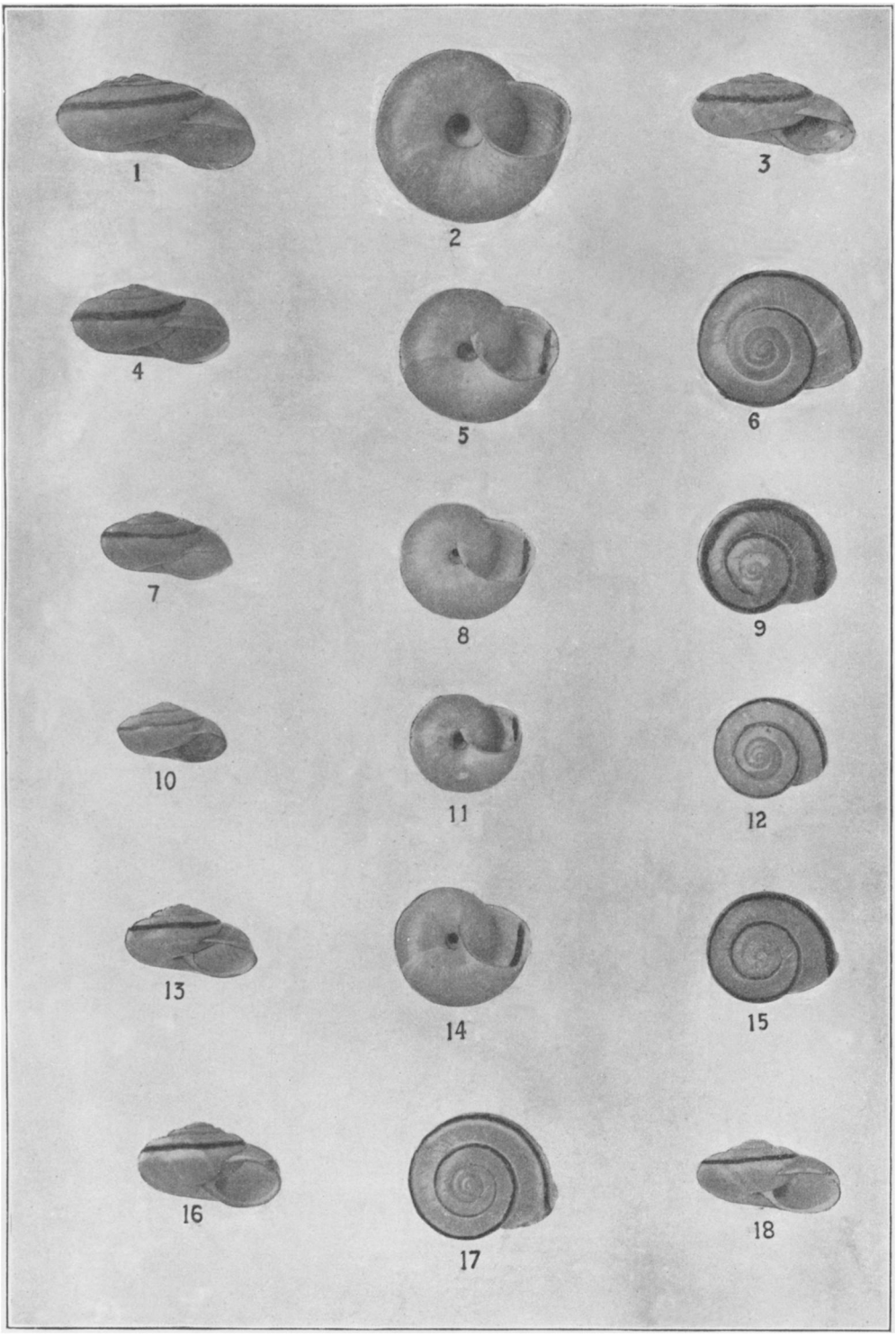
Explanation of Plates XIX to XXI.

Plate XIX.— Figs. 1, 2, 3—*Sonorella dalli* Bartsch. Tanner Canyon.
Figs. 4, 5, 6—*Sonorella granulatissima latior* Pils. Cotypes.
Figs. 7, 8—*Sonorella granulatissima* Pils. Cotypes.
Fig. 9—*Sonorella granulatissima* Pils. Miller Canyon.
Figs. 10, 11, 12—*Sonorella granulatissima parva* Pils. Cotypes.
Figs. 13, 14, 15—*Sonorella danielsi* Pils. and Ferr. Cotypes.
Fig. 16—*Sonorella huachucana* Pils. Bear Canyon.
Fig. 17—*Sonorella huachucana* Pils. Type.
Fig. 18—*Sonorella danielsi* P. and F., brown variety. Ash Canyon, No. 94,385.

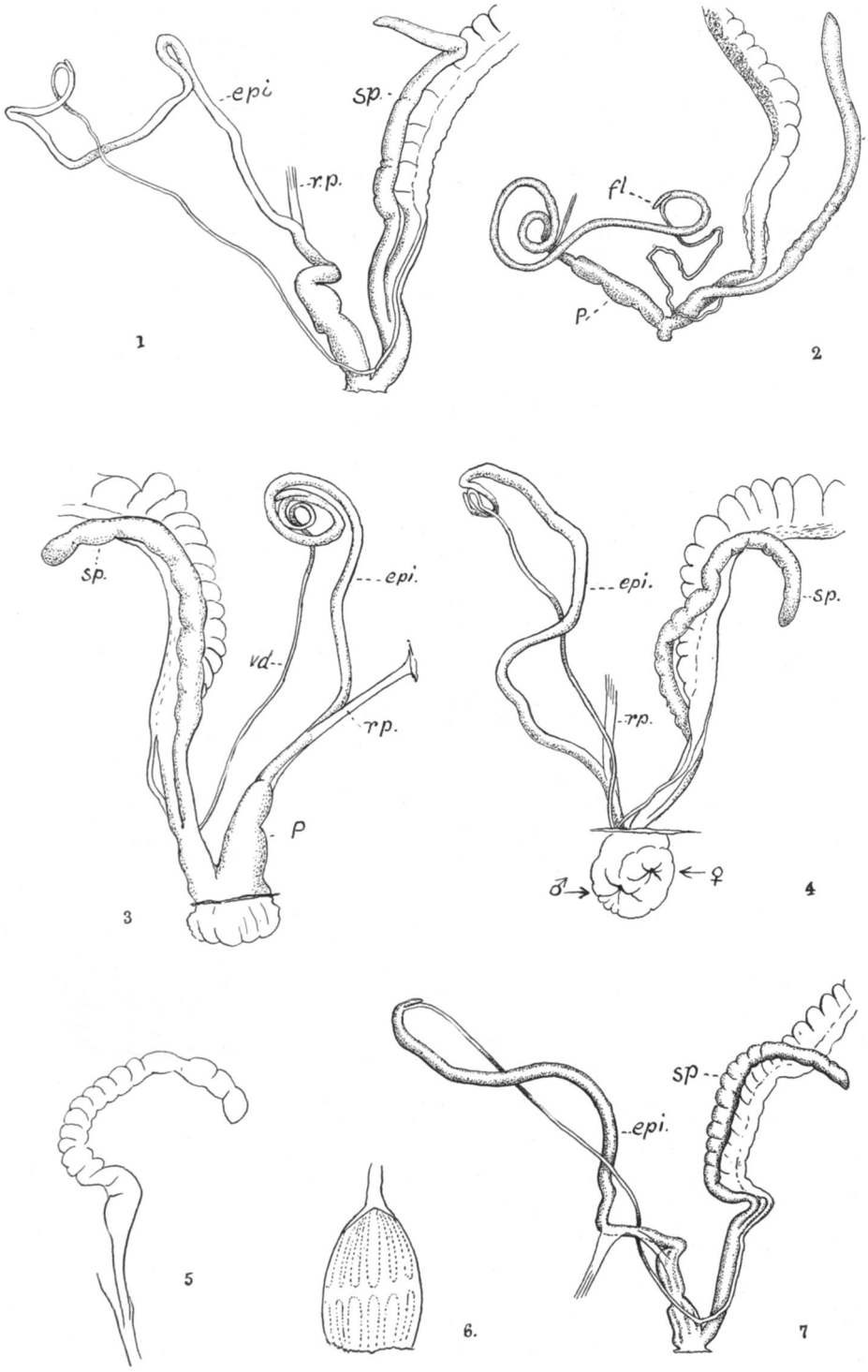
Plate XX.—Fig. 1—*Ashmunella levettei ursina* Pils. and Ferr. No. 94,351.
Fig. 2—*Ashmunella l. angigyra* Pils. No. 83,269.
Fig. 3—*Ashmunella varicifera* Anc. No. 94,341.
Fig. 4—*Ashmunella levettei ursina* P. and F. No. 94,349. Atrium and ends of penis and vagina protruding.
Fig. 5—*Ashmunella varicifera* Anc. Spermatheca of another individual.
Fig. 6—*Ashmunella varicifera* Anc. Penis opened.
Fig. 7—*Ashmunella microdonta* Pilsbry and Ferriss. No. 94,347. One of the cotypes.

Plate XXI.—Fig. 1—*Sonorella granulatissima* Pils. No. 83,257. Cotype.
Fig. 2—Ditto. Penis opened to show papilla.
Fig. 3—Ditto. Penis, epiphallus and flagellum.
Fig. 4—Ditto. No. 94,336. Miller Canyon.
Fig. 5—*Sonorella danielsi* Pilsbry and Ferriss. No. 94,337.
Fig. 6—*Sonorella danielsi* Pilsbry and Ferriss. No. 94,318. Type.
Fig. 7—*Sonorella g. latior* Pils. No. 94,387. Tanner Canyon.

Plate XXII.—Figs. 1, 2, 3—*Sonorella rinconensis* Pils. and Ferr. Central, lateral and marginal teeth.
Fig 4—*Sonorella rinconensis*. Type, genitalia. × 2.
Fig. 5—*Sonorella dalli* Bartsch. No. 94,384, genitalia. × 2.
Fig. 6—*Sonorella dalli* Bartsch. Jaw.



PILSBRY AND FERRISS: MOLLUSCA OF SOUTHWESTERN STATES.



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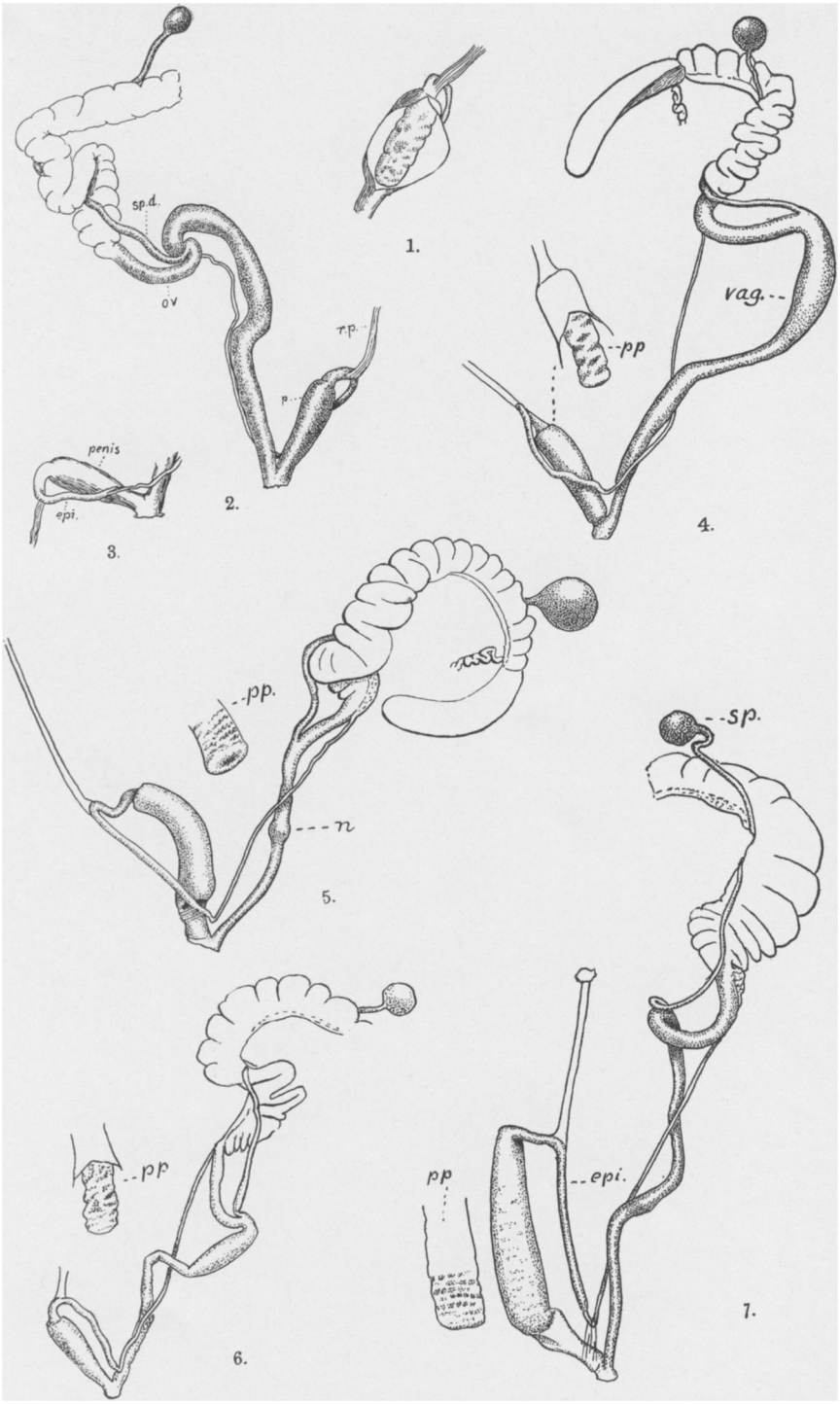

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